Beam Structure for PRISM/PRIME from Project X

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November, 2010

Abstract

This note describes a possible beam structure to deliver multi-MW beam to the PRISM/PRIME experiment during the Project X era. The scheme assumes that the Recycler is used as a storage ring. This will allow the use of beam from the Booster in case that experiment is ready before Project X is completed.

Introduction

At present, the Fermilab Booster provides 11 batches of 4x10^12 protons to the Main Injector. This means that the Main Injector regularly stores ~5x10^13 protons. Based on this, studies have been conducted that show that the Recycler will be capable of accumulating 1.4x10^14 protons from Project X to be transferred to the Main Injector. In this note I will assume that the Recycler is capable of storing half of that, 5x10^13 and that Project X is an 8 GeV, 1mA CW linac, or pulsed linac from 3 to 8 GeV. The other possibility is the 3 GeV CW linac will inject the same amount of beam into the Main Injector, which will accelerate it to 8 GeV and transfer it to the Recycler.

Beam Packaging

The system that we envision is very similar to the one that was proposed for the g-2 experiment. A 1 mA CW linac makes 6.25x10^15 protons/sec, so in 10 msec we can get 3x10^13 protons, assuming that the H- beam is chopped, 200 ns on and 200 ns off. This is injected into the Recycler RF system with h=28. Assuming that the experiment expects ~50 nsec-long bunches, the h=28 RF system is used to do adiabatic bunching. To avoid the need for large RF voltage and at this stage have simple numeric, I will assume that the bunching process takes 18 msecs. So in 28 msec the beam is prepared in 28 bunches. In the next 72 msec, it is extracted one bunch at time to the experiment and the process is repeated. This also allows for the linac to be pulsed with a 10 Hz rate. The experiment gets beam with an average rate of 280 Hz.

Construction and Installation

Once the beam from Project X is delivered to the Recycler, the only hardware needed is a set of cavities for creating ~50 nsec bunches out of 200 ns-long beam bunches. This can be achieved by moving existing 2.5 MHz coalescing cavities from the Main Injector to the Recycler. This was suggested as a way of creating the bunch structure for the g-2 experiment. The main concerns are the design and construction of a kicker system with an average repetition rate of 280 Hz.

Conclusions

With the suggested beam delivery system, PRISM/PRIME can get up to ~10^15 protons per second on target. Using the Recycler and coalescing cavities eliminates any new additional construction. The experiment can start delivering beam from the Booster before project X is completed.

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